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Dehumidification process for granulated ~~plastics~~plastic materials and a plant operating in accordance with the process

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Technical ~~f~~Field ~~o~~Of ~~t~~The ~~i~~Invention

The present invention relates to a dehumidification process for granulated plastics materials ~~according to the characteristics set forth in the preamble to independent Claim 1~~ and to a plant operating in accordance with the process.~~, according to the preamble to independent Claim 12.~~

~~Technological b~~Background ~~o~~Of ~~t~~The ~~i~~Invention

The invention is intended preferably ~~but not exclusively~~ for application in the technical field of the processing of plastics materials, in particular in the sector of the transformation of granulated plastics materials by injection and ~~moulding~~molding.

In this field, it is known to provide a step for the dehumidification of the granules immediately upstream of the injection and ~~moulding~~molding step for which the granules are required to arrive with a very low moisture level depending on the intended use of the final product.

This requirement is even more necessary for plastics materials which have marked hygroscopic properties such as, for example, plastics materials based on polyethylene terephthalate (PET).

In order to remove moisture from the granules being processed,

methods are known which provide for the stripping of the moisture from the granules by contact with a process gas the moisture content of which is reduced substantially in a suitable treatment unit.

Typically, the process gas used is air which is dehumidified in the treatment unit until a dew point of the air of between -50° and -60° is reached before being put in contact with the granules to be dried.

With these low levels of moisture in the process air, the granules are dried in a suitable manner but increased production of undesired degradation products, in particular formaldehyde and acetaldehyde, has been encountered in the subsequent plasticization step.

These compounds may cause some problems of quality in the final product since they are characterized by strong and pungent ~~odours~~odors and may migrate through the polymer matrix to its surface. In the particular case in which the final product produced from the PET granules is a bottle for containing beverages of delicate ~~flavour~~flavor, known in the art as "soft drinks" such as, for example, still water, the presence of these compounds, even in minimal quantities, may adversely affect the ~~flavour~~flavor of such beverages.

In the technical field to which the invention relates, there are also moisture-removal processes, for example, known from European patent application No. 1306635 and Japanese patent application No. 2000281825, in which, for energy-saving reasons, a capability is provided for regulation of the drying of the process air in dependence on the quantity of granules to be treated. However, this regulation is performed on the flow of air which is sent to the moisture-removal treatment and does not solve the problem set out above.

Brief Description ~~o~~Of ~~t~~The ~~i~~Invention

The problem underlying the present invention is that of providing a dehumidification process for granulated plastics materials and a plant operating in accordance with the process which are designed structurally and functionally to overcome the limitations set out above with reference to the prior art cited.

Within the scope of this problem, a principal object of the invention is to provide a process and a plant which have greater operative flexibility and which permit effective energy saving.

This problem is solved and this object is achieved by the ~~present invention by means of a~~ dehumidification process and a plant of the present invention ~~operating in accordance with the process, according to the appended claims.~~ The dehumidification process of the present invention for granulated plastic materials includes a process-gas treatment step in which the moisture content of the process-gas is reduced substantially. The dehumidification process also includes a subsequent granular-treatment step by which the granules are contacted by the process-gas having a reduced moisture content. In the process-gas treatment step, the reduction of the moisture content of the process-gas is regulated in dependence on the granules to be treated. The plant of the present invention for dehumidification of granulated plastic materials includes a process-gas treatment unit which is arranged to reduce the moisture content of the process-gas substantially and a granular treatment unit for the treatment of the granules by the process-gas. The plant also includes regulation means for the regulation of the moisture content of the process-gas.

Brief dDescription oOf tThe dDrawings

The characteristics and the advantages of the invention will become clearer from the detailed description of some preferred embodiments thereof which are illustrated by way of non-limiting example with reference to the appended drawings, in which:

Figure 1 is a schematic view of a plant for dehumidifying granulated plastics materials, arranged for operating in accordance with the process of the present invention, and

Figure 2 is a schematic view of a variant of the dehumidifying plant of Figure 1.

Preferred eEmbodiments oOf tThe iInvention

In the appended drawings, a plant for dehumidifying granulated plastics materials, in particular plastics materials based on polyethylene terephthalate (PET), is generally indicated 1.

The plant 1 is arranged immediately upstream of a unit for injecting and ~~moulding~~molding the granules, which is conventional and is not shown in the appended drawings, and downstream of a system for loading the granules to be dried, which is shown only partially and indicated 2.

The plant 1 comprises a unit 3 for treating the granules coming from the loading system 2, a unit 4 for treating a process gas used for dehumidifying the granules in the treatment unit 3, as well as a circuit 5 which connects the granule-treatment unit 3 to the gas-treatment unit 4 in order to convey the process gas between them.

The granule-treatment unit 3 in turn comprises a hopper 6 at the top of which the PET granules coming from the loading system 2 are loaded, and to the bottom 6a of which the injection and moulding unit is connected.

The unit 4 for the treatment of the process gas which, in the preferred embodiment described herein is air, in turn comprises a pair of dehumidification towers 7a and 7b in which suitable molecular sieves are provided for substantially reducing the moisture content of the air passing through them.

In this context "substantial reduction" of the moisture content of the air means the production of air having a dew point below -10°C.

The process circuit 5 comprises a delivery line 8 extending between the towers 7a, 7b and the interior of the hopper 6, into which the delivery line 8 opens in order to admit the process gas to the hopper, into contact with the granules to be dried. The line 8 preferably opens in the region of the bottom 6a of the hopper so that the contact between process gas and granules takes place with a counter-current. A heater 9 is provided between the process-gas treatment units and the hopper 6, for heating the gas to a suitable temperature for admission to the hopper.

Moreover, a return line 10 for the process gas extends from the top of the hopper 6 to the towers 7a, 7b, the process gas passing through filters 11 for separating from the gas any particulates extracted from the hopper 6, and through a pair of blowers 12.

The plant 1 further comprises a regeneration circuit 15 which draws in air from the exterior and causes it to circulate inside the towers 7a, 7b and then to be readmitted to the environment. The towers 7a, 7b in fact have to alternate between operative periods and regeneration phases so that, at a given moment, only one of the two towers is operative, whilst the other is in the regeneration phase.

In order to select which of the two towers should be connected to the regeneration circuit 15 and which to the process circuit 5, the plant 1

comprises a first unit and a second unit, indicated 13 and 14, respectively, for the distribution of the process gas to the towers 7a, 7b.

These distribution units serve to direct the process gas towards the dehumidification tower which is operative at the time in question, which is represented in Figure 1 by the tower 7a.

According to a principal characteristic of the invention, the plant 1 comprises regulation means 20 for regulating the moisture content of the process gas.

This regulation is achieved by the bypassing of a fraction of process gas between positions upstream and downstream of the towers 7a, 7b.

The bypass means comprise a line 21 which extends directly between the first and second distribution units 13, 14 and in which a regulation valve 22, preferably of the modulation type, is mounted.

The degree of opening of the regulation valve 22 is controlled by control means 23 comprising a humidity sensor 24 disposed in the delivery line 8.

The regulation means 20 enable the moisture content of the process gas admitted to the hopper 6 to be varied since adjustment of the opening of the valve 22 causes a fraction of the process gas destined for dehumidification in the tower 7a to be passed from the distribution unit 13 directly to the distribution unit 14 without being treated.

The moisture content of the gas admitted to the hopper 6 will therefore be varied in dependence on the value of the bypassed gas fraction relative to the remaining gas fraction which is subjected to dehumidification in the tower 7a.

By virtue of the process of the invention, it is therefore possible to regulate the moisture content of the process gas in dependence on the type

of granules treated in the hopper 6. This regulation is preferably performed between a minimum humidity value corresponding to a dew point of the gas of about -60°C and a maximum value thereof which in turn corresponds to a dew point of about -10°C.

In particular, it is possible to set a relatively low humidity value corresponding to a dew point of between -50°C and -60°C when the granules treated in the hopper are intended for the production of containers (typically bottles) for beverages having a so-called strong ~~flavour~~flavor, particularly carbonated beverages which require containers having good gas-barrier properties.

In this case, the dehumidifying process described herein enables the desired mechanical and barrier properties to be achieved.

For the treatment of granules intended for the production of containers for beverages having a so-called delicate ~~flavour~~flavor ("soft drinks"), on the other hand, it is possible to set a relatively high humidity value for the gas admitted to the hopper, for example, corresponding to a dew point of between -10°C and -40°C. Preference is thus given to the reduction of the formation of aldehydes which may alter the flavour of the beverage which, moreover, is not normally carbonated and therefore does not require good gas-barrier properties.

In the variant of the plant 1 shown in Figure 2, there is provision for the insertion of a humidification unit 30 in the delivery line 8, for partially humidifying the process air.

This option may be very useful when the bypassed air fraction is very high in comparison with the air fraction treated by the towers 7a or 7b. In such cases, there may in fact be a tendency for acetaldehyde to accumulate in the process air over time in the absence of the at least partial absorption

effect performed on the air by the towers 7a or 7b.

By virtue of the variant of the plant described herein, it is possible to pass through the towers 7a or 7b a fraction of process air greater than that which is strictly necessary to achieve the desired final moisture content so as to bring about the absorption of a greater quantity of acetaldehyde present in the air output from the hopper 6. Naturally, the moisture content of the process air output from the second distribution unit 14 will be less than the desired final value but it will be possible to correct that value by partially humidifying the air in the humidification unit 30.

It will be noted that the plant as a whole thus acquires an additional degree of freedom since the final degree of humidity is rendered partially independent of the fraction of air treated by the towers.

A further method of regulating the moisture content of the process air provides for the possibility of altering the efficiency of the absorption towers 7a and 7b. In particular, their regeneration parameters may be varied in order to obtain different operative performance, for example, by modifying the regeneration temperatures (minimum and maximum), or the time taken for the transition from one temperature to the other.

The present invention thus solves the problem discussed above with reference to the prior art cited, at the same time offering many further advantages, amongst which is a reduction in the running cost of the dehumidification towers which in fact treat only a fraction of the process gas.